TITLE

FLUID ANALYZING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a fluid analyzing apparatus, and in particular to a fluid analyzing apparatus that sequentially or simultaneously analyzes a multiplex fluid sample.

Description of the Related Art

A multiplex fluid sample, such as blood and urine, may be composed of many constituents with unknown concentrations. The multiplex fluid sample may include substances of interest or prohibited substances. In order to analyze or sieve out specific constituents in the multiplex fluid sample, U.S. patent No. 6,398,765, 6,306,659 and 6,144,447 discloses several conventional fluid analyzing devices.

In the U.S. patent No. 6,398,765, the fluid analyzing device is a complex structural design. It is composed of many ducts for analyzing of breast milk.

In the U.S. patent No. 6,306,659, the fluid analyzing device belongs to one kind of microfluidic devices. The device with numerous working areas is used for analyzing a plurality of compounds and performing high throughput screening assays. Meanwhile, the micro-ducts in this fluid analyzing device are manufactured by means of a complex MEMS process. The fluid analyzing

device does not disclose the function of sequentially or simultaneously analyzing the compounds.

In the U.S. patent No. 6,144,447, the fluid analyzing device employs electrochemical and optical means to measure different physical or chemical parameters of a multiplex fluid sample in a flow cell. The electrochemical and optical means are directly disposed on the wall of the flow cell of the fluid analyzing device, thereby limiting the size of the flow cell and the amount of the multiplex fluid sample flowing therein. Accordingly, since the multiplex fluid sample flows in the flow cell with a limited size, the friction and surface tension between the multiplex fluid sample and wall of the flow cell are greater. The flowing speed of the multiplex fluid sample near the wall of the flow cell is different from that near the center thereof. Thus, the analysis of the multiplex fluid sample is adversely affected.

Hence, there is a need to provide an improved fluid analyzing apparatus to overcome the aforementioned problems. The present fluid analyzing apparatus sequentially or simultaneously detects and analyzes a multiplex fluid sample with suitable analyzing elements. Furthermore, the fluid analyzing apparatus analyzes and detects the multiplex fluid sample by allowing the multiplex fluid sample to sequentially or simultaneously flow through a plurality of target chambers with a suitable volume, thereby enhancing the speed and analysis thereof.

SUMMARY OF THE INVENTION

Accordingly, an object of the invention is to provide a fluid analyzing apparatus to sequentially analyze a multiplex fluid sample. The fluid analyzing apparatus comprises a first unit, a second unit, a third unit, a first analyzing element and a second analyzing element. The first unit has a fluid inlet, a first upper portion and a fluid outlet. The first upper portion is formed on the lower part of the first unit. The multiplex fluid sample flows into the fluid analyzing apparatus via the fluid inlet and flows out of the fluid analyzing apparatus via the fluid outlet. The second unit is disposed under the first unit and has a pipeline, a first lower portion and a second upper portion. The first lower portion is formed on the upper part of the second unit and corresponds to the first upper portion to combine the first upper portion to form a first target chamber. The second upper portion is formed on the lower part of the second unit. The pipeline is sequentially connected to the fluid inlet, first lower portion, second upper portion and fluid outlet. The third unit is disposed under the second unit and has a second lower portion. The second lower portion is formed on the upper part of the third unit and corresponds to the second upper portion to combine the second upper portion to form a second target chamber. The first analyzing element is disposed in the first target chamber to analyze and detect the multiplex fluid sample. The second analyzing

element is disposed in the second target chamber to analyze and detect the multiplex fluid sample.

Accordingly, the pipeline of the second unit is sequentially connected to the fluid inlet, first lower portion, second upper portion and fluid outlet with an inclined angle (45 degrees).

Accordingly, the fluid analyzing apparatus further comprises a first sealing element disposed between the first upper portion and first lower portion to prevent leakage of the multiplex fluid sample from the first target chamber.

Accordingly, the fluid analyzing apparatus further comprises a second sealing element disposed between the second upper portion and second lower portion to prevent leakage of the multiplex fluid sample from the second target chamber.

Accordingly, the first analyzing element further comprises a first signal connecting portion extending out of the fluid analyzing apparatus.

Accordingly, the second analyzing element further comprises a second signal connecting portion extending out of the fluid analyzing apparatus.

Accordingly, the first and second analyzing elements are physical or/and biological or/and chemical sensing elements.

Accordingly, the physical sensing element is an electrode, a quartz crystal microbalance (QCM), a flexural plate wave (FPW) device, a thermal sensing element, a pressure sensing element, an optical sensing element or a viscosity sensing element.

Accordingly, the biological sensing element is a nucleic acid, protein, antibody, enzyme, microorganism or other biochemical substances.

Accordingly, the fluid analyzing apparatus further comprises at least one bolt to combine the first, second and third units.

Accordingly, the first, second and third units are composed of acrylic, Teflon or glass.

Accordingly, the fluid analyzing apparatus further comprises a pump to pump the multiplex fluid sample into the fluid analyzing apparatus.

Accordingly, the multiplex fluid sample is respectively analyzed or detected by the first and second analyzing elements.

Another object of the invention is to provide a fluid analyzing apparatus to simultaneously analyze a multiplex fluid sample. The fluid analyzing apparatus comprises a first unit, a second unit, a third unit, a first analyzing element and a second analyzing element. The first unit has a fluid inlet and a dispersing portion disposed on the lower part of the first unit and connected to the fluid inlet. The multiplex fluid sample flows into the dispersing portion via the fluid inlet. The second unit is disposed under the first unit and has a first pipeline, a second pipeline, a first upper portion, a second upper portion and a collective portion. The first upper portion, second upper portion and collective portion are formed on the lower part of the second unit. The first pipeline is connected to the dispersing portion of the first unit, first upper portion

and collective portion. The second pipeline is connected to the dispersing portion of the first unit, second upper portion and collective portion. The third unit is disposed under the second unit and has a first lower portion, a second lower portion and a fluid outlet. The first lower portion is formed on the upper part of the third unit and corresponds to the first upper portion to combine the first upper portion to form a first target chamber. The second lower portion is formed on the upper part of the third unit and corresponds to the second upper portion to combine the second upper portion to a form second target chamber. The fluid outlet is connected to the collective portion of the second unit. The multiplex fluid sample flows out of the fluid analyzing apparatus via the fluid outlet. The first analyzing element is disposed in the first target chamber to analyze and detect the multiplex fluid sample. The second analyzing element is disposed in the second target chamber to analyze and detect the multiplex fluid sample.

Accordingly, the first pipeline of the second unit is connected to the dispersing portion of the first unit, first upper portion and collective portion with an inclined angle, and the second pipeline of the second unit is connected to the dispersing portion of the first unit, second upper portion and collective portion with the same inclined angle.

Accordingly, the fluid analyzing apparatus further comprises a first sealing element disposed between the first upper portion and first lower portion to prevent

leakage of the multiplex fluid sample from the first target chamber.

Accordingly, the fluid analyzing apparatus further comprises a second sealing element disposed between the second upper portion and second lower portion to prevent leakage of the multiplex fluid sample from the second target chamber.

Accordingly, the first analyzing element further comprises a first signal connecting portion extending out of the fluid analyzing apparatus.

Accordingly, the second analyzing element further comprises a second signal connecting portion extending out of the fluid analyzing apparatus.

Accordingly, the first and second analyzing elements are physical or/and biological or/and chemical sensing elements.

Accordingly, the physical sensing element is an electrode, a quartz crystal microbalance (QCM), a flexural plate wave (FPW) device, a thermal sensing element, a pressure sensing element, an optical sensing element or a viscosity sensing element.

Accordingly, the biological sensing element is a nucleic acid, protein, antibody, enzyme, microorganism or other biochemical substances.

Accordingly, the fluid analyzing apparatus further comprises at least one bolt to combine the first, second and third units.

Accordingly, the dispersing portion of the first unit is circular.

Accordingly, the first, second and third units are composed of acrylic, Teflon or glass.

Accordingly, the fluid analyzing apparatus further comprises a pump to pump the multiplex fluid sample into the fluid analyzing apparatus.

Accordingly, the multiplex fluid sample is respectively analyzed or detected by the first and second analyzing elements.

A detailed description is given in the following embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

FIG. 1 is a schematic view showing the concept of sequential analysis of the fluid analyzing apparatus of the invention;

FIG. 2 shows the inner structure of the fluid analyzing apparatus of the first embodiment of the invention;

FIG. 3 is a schematic view showing the concept of simultaneous analysis of the fluid analyzing apparatus of the invention; and

FIG. 4 shows the inner structure of the fluid analyzing apparatus of the second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

First embodiment

Referring to FIG. 1, the fluid analyzing apparatus of this embodiment is directed to the concept of sequential analysis of a multiplex fluid sample. The multiplex fluid sample sequentially flows through a first target chamber 11, a second target chamber 12, a third target chamber 13 and so on via a fluid inlet 1. Then, the multiplex fluid sample flows out via a fluid outlet 2. Additionally, same or different analyzing elements are respectively disposed in the first target chamber 11, second target chamber 12 and third target chamber 13 to analyze the multiplex fluid sample or sieve out specific constituents from the multiplex fluid sample.

Referring to FIG. 2, the fluid analyzing apparatus 100 includes a first unit 110, a second unit 120 and a third unit 130. The first unit 110 has a fluid inlet 111, a first upper portion 112, a third upper portion 113, a fifth upper portion 114 and a fluid outlet 115. Meanwhile, the first upper portion 112, third upper portion 113 and fifth upper portion 114 are formed on the lower part of the first unit 110.

The second unit 120 is disposed under the first unit 110 and has a pipeline 121, a first lower portion 122, a second upper portion 123, a third lower portion 124, a fourth upper portion 125, a fifth lower portion 126 and a sixth upper portion 127. Meanwhile, the first lower portion 122, third lower portion 124 and fifth lower portion 126 are formed on the upper part of the second

unit 120 and respectively correspond to the first upper portion 112, third upper portion 113 and fifth upper portion 114. The second upper portion 123, fourth upper portion 125 and sixth upper portion 127 are formed on the lower part of the second unit 120.

The third unit 130 is disposed under the second unit 120 and has a second lower portion 131, a fourth lower portion 132 and a sixth lower portion 133. Meanwhile, the second lower portion 131, fourth lower portion 132 and sixth lower portion 133 are formed on the upper part of the third unit 130 and respectively correspond to the second upper portion 123, fourth upper portion 125 and sixth upper portion 127.

As shown in FIG. 2, when the first unit 110, second unit 120 and third unit 130 are fixed together by two bolts 140, the first upper portion 112, second upper portion 123, third upper portion 113, fourth upper portion 125, fifth upper portion 114 and sixth upper portion 127 respectively combine the first lower portion 122, second lower portion 131, third lower portion 124, fourth lower portion 132, fifth lower portion 126 and sixth lower portion 133 to form a first target chamber A, a second target chamber B, a third target chamber C, a fourth target chamber D, a fifth target chamber E and a sixth target chamber F. Meanwhile, the pipeline 121 of the second unit 120 is sequentially connected to the fluid inlet 111 of the first unit 110, first target chamber A, second target chamber B, third target chamber C, fourth target chamber D, fifth target chamber E, sixth target chamber F and fluid outlet 115 of the first unit

110 with an inclined angle of 45 degrees. Thus, the multiplex fluid sample can smoothly flow in the pipeline 121 and bubbles halting therein may be prevented (particularly when the multiplex fluid sample is liquid and the diameter of the pipeline 121 is small, such as 1 mm).

Additionally, a first analyzing element (not shown), a second analyzing element (not shown), a third analyzing element (not shown), a fourth analyzing element (not shown), a fifth analyzing element (not shown) and a sixth analyzing element (not shown) are respectively disposed in the first target chamber A, second target chamber B, third target chamber C, fourth target chamber D, fifth target chamber E and sixth target chamber F. The first, second, third, fourth, fifth and sixth analyzing elements may have different analyzing functions. For example, the first, second, third, fourth, fifth and sixth analyzing elements may be a physical sensing element, a biological sensing element or a chemical sensing element which requires an additional identification element and a specific transducer. The physical sensing element may be and is not limited to an electrode, a quartz crystal microbalance (QCM), a flexural plate wave (FPW) device, a thermal sensing element, a pressure sensing element, an optical sensing element or a viscosity sensing element. The biological sensing element is a nucleic acid, protein, antibody, enzyme, microorganism or other biochemical substances. Additionally, the first, second, third, fourth, fifth and sixth analyzing elements respectively have a first signal connecting portion (not

shown), a second signal connecting portion (not shown), a third signal connecting portion (not shown), a fourth signal connecting portion (not shown), a fifth signal connecting portion (not shown) and a sixth signal connecting portion (not shown) extending out of the fluid analyzing apparatus 100 to output corresponding analyzing signals to other devices for further processing.

Accordingly, since the multiplex fluid sample flows in the pipeline 121, first target chamber A, second target chamber B, third target chamber C, fourth target chamber D, fifth target chamber E and sixth target chamber F, a sealing element, such as a rubber O-ring, is disposed between the upper portion and lower portion of each target chamber to prevent the multiplex fluid sample from flowing out of each target chamber via the connection thereof.

In this embodiment, the fluid analyzing apparatus 100 is composed of acrylic and the size thereof is approximately 90 mm $\times$ 20 mm $\times$ 49 mm. The diameter of the pipeline 121 is 1 mm. The volume of each target chamber is equal to or smaller than 30 uL.

When a multiplex fluid sample, particularly a multiplex fluid sample with mixed substances, is pumped into the fluid analyzing apparatus 100 via the fluid inlet 111 by a pump (not shown), the multiplex fluid sample flows into the first target chamber A, second target chamber B, third target chamber C, fourth target chamber D, fifth target chamber E and sixth target chamber F in sequence. The analyzing element disposed in each target chamber reacts with specific constituents in

the multiplex fluid sample to output a corresponding signal. Then, the multiplex fluid sample flows out of the fluid analyzing apparatus 100 via the fluid outlet 115.

Specifically, the fluid analyzing apparatus 100 is not limited to the six target chambers A, B, C, D, E and F. Namely, the fluid analyzing apparatus 100 may have more target chambers to analyze and detect the multiplex fluid sample.

The fluid analyzing apparatus 100 of this embodiment has the following advantages. The fluid analyzing apparatus 100 may be manufactured by means of a common mechanical process, thereby reducing the manufacturing costs thereof. The fluid analyzing apparatus 100 can be disassembled to three units, such that the analyzing elements therein are easily disposed and replaced. Each target chamber has a predetermined volume, such that the amount of fluid in each target chamber increases and the reaction sensitivity thereof is enhanced. The fluid analyzing apparatus 100 can analyze and detect a small amount of fluid, particularly when only a small amount of fluid, such as a drop of blood, exists. Since the pipeline 121 is connected to the first, second, third, fourth, fifth and sixth target chambers with an inclined angle (45 degrees), the bubbles formed therein can be easily removed by the sample when the sample is liquid. Thus, interference does not occur during analysis.

Second embodiment

Referring to FIG. 3, the fluid analyzing apparatus of this embodiment is directed to the concept of

simultaneous analysis of a multiplex fluid sample. The multiplex fluid sample simultaneously flows through a first target chamber 31, a second target chamber 32, a third target chamber 33 and so on via a fluid inlet 3. Then, the multiplex fluid sample gathers and flows out via a fluid outlet 4. Additionally, same or different analyzing elements are respectively disposed in the first target chamber 31, second target chamber 32 and third target chamber 33 to analyze the multiplex fluid sample or sieve out specific constituents from the multiplex fluid sample.

Referring to FIG. 4, the fluid analyzing apparatus 200 includes a first unit 210, a second unit 220 and a third unit 230. The first unit 210 has a fluid inlet 211 and a dispersing portion 212. Meanwhile, the dispersing portion 212 is formed on the lower part of the first unit 210 and connected to the fluid inlet 211. Additionally, the dispersing portion 212 is circular.

The second unit 220 is disposed under the first unit 210 and has a first pipeline 221, a second pipeline 222, a first upper portion 223, a second upper portion 224 and a collective portion 225. Meanwhile, the first upper portion 223, second upper portion 224 and collective portion 225 are formed on the lower part of the second unit 220. The first pipeline 221 is connected to the dispersing portion 212 of the first unit 210, first upper portion 223 and collective portion 225. The second pipeline 222 is connected to the dispersing portion 212 of the first unit 210, second upper portion 224 and collective portion 225.

The third unit 230 is disposed under the second unit 220 and has a first lower portion 231, a second lower portion 232 and a fluid outlet 233. Meanwhile, the first lower portion 231 is formed on the upper part of the third unit 230 and corresponds to the first upper portion 223, and the second lower portion 232 is formed on the upper part of the third unit 230 and corresponds to the second upper portion 224.

As shown in FIG. 4, when the first unit 210, second unit 220 and third unit 230 are fixed together by a bolt (not shown), the first upper portion 223 combines the first lower portion 231 to form a first target chamber A' and the second upper portion 224 combines the second lower portion 232 to form a second target chamber B'. Meanwhile, the first pipeline 221 of the second unit 220 is connected to the dispersing portion 212 of the first unit 210, first upper portion 223 and collective portion 225 with an inclined angle of 45 degrees, and the second pipeline 222 of the second unit 220 is connected to the dispersing portion 212 of the first unit 210, second upper portion 224 and collective portion 225 with the same inclined angle of 45 degrees. Thus, the multiplex fluid sample can flow smoothly in the first pipeline 221 and second pipeline 222 and bubbles halted therein may be prevented, specifically when the sample is liquid and the diameter of the first pipeline 221 and second pipeline 222 is small, such as 1 mm.

Additionally, a first analyzing element (not shown) and a second analyzing element (not shown) are respectively disposed in the first target chamber A' and

second target chamber B'. The first and second analyzing elements may have different analyzing functions. For example, the first and second analyzing elements may be a physical sensing element, a biological sensing element or a chemical sensing element which requires an additional identification element and a specific transducer. The physical sensing element may be and is not limited to an electrode, a quartz crystal microbalance (QCM), a flexural plate wave (FPW) device, a thermal sensing element, a pressure sensing element, an optical sensing element or a viscosity sensing element. The biological sensing element is a nucleic acid, protein, antibody, enzyme, microorganism or other biochemical substances. Additionally, the first and second analyzing elements respectively have a first signal connecting portion (not shown) and a second signal connecting portion (not shown) extending out of the fluid analyzing apparatus 200 to output corresponding analyzing signals to other devices for further processing.

Accordingly, since the multiplex fluid sample flows in the first pipeline 221, first target chamber A', second pipeline 222 and second target chamber B', a sealing element, such as a rubber O-ring, is disposed between the upper portion and lower portion of each target chamber to prevent the multiplex fluid sample from flowing out of each target chamber via the connection thereof.

In this embodiment, the fluid analyzing apparatus 200 is composed of acrylic and the size thereof is approximately 60 mm (diameter) × 60 mm (height). The

diameter of the first pipeline 221 and second pipeline 222 is 1 mm. The volume of each target chamber is equal to or smaller than 30 uL.

When a multiplex fluid sample, particularly a multiplex fluid sample containing a mixture of substances, is pumped into the fluid analyzing apparatus 200 via the fluid inlet 211 by a pump (not shown), the multiplex fluid sample flows into the dispersing portion 212 and is thereby dispersed. Then, the multiplex fluid sample simultaneously flows into the first target chamber A' and second target chamber B' via the first pipeline 221 and second pipeline 222. The analyzing element disposed in each target chamber reacts with specific constituents in the multiplex fluid sample to output a corresponding signal. Eventually, the multiplex fluid sample flows into the collective portion 225 via the first pipeline 221 and second pipeline 222 and flows out of the fluid analyzing apparatus 200 via the fluid outlet 233.

Specifically, the fluid analyzing apparatus 200 is not limited to the two target chambers A' and B'. Namely, the fluid analyzing apparatus 200 may have more target chambers to analyze and detect the multiplex fluid sample, thereby reducing the analyzing time thereof.

The fluid analyzing apparatus 200 of this embodiment has the following advantages. The fluid analyzing apparatus 200 may be manufactured by means of a common mechanical process, thereby reducing the manufacturing costs thereof. The fluid analyzing apparatus 200 can be disassembled to three units, such that the analyzing

elements therein are easily disposed and replaced. Each target chamber has a predetermined volume, such that the amount of fluid in each target chamber increases and the reaction sensitivity thereof is enhanced. The fluid analyzing apparatus 200 simultaneously analyzes the multiplex fluid sample when the multiplex fluid sample is sufficient, thereby reducing the time spent in analyzing the multiplex fluid sample. Since the first pipeline 221 and second pipeline 222 are respectively connected to the first target chamber A' and second target chamber B' with an inclined angle (45 degrees), the bubbles formed therein can be easily removed by the sample when the sample is liquid. Thus, interference does not occur during analysis.

While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.